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309372

GEOLOGY & HYDROLOGY REPORT

MALLARD LAKE LANDFILL

DU PAGE COUNTY, ILLINOIS

SITE OWNERS

FOREST PRESERVE DISTRICT OF DU PAGE COUNTY

CONTRACTOR

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GEOLOGY AND HYDROLOGY REPORT

MALLARD LAKE LANDFILL

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MALLARD LAKE LANDFILL
DU PAGE COUNTY, ILLINOIS

SCOPE & BACKGROUND

The Mallard Lake Landfill Site is located in the eastern portions of Section 12 and 13, Township 40 North, Range 9 East; and the western portion of Section 7 and northern portion of Section 18, Township 40 North, Range 10 East in Du Page County, Illinois. The data drawn upon for this report include 30 subsurface borings, performed at various times by Testing Service Corporation, 12 resistivity traverses, two reports regarding subsurface conditions at the site, on-site observation, and various maps and publications by the Illinois State Geological Survey.

In 1973, resistivity traverses and Borings 1 through 20 were performed at the site. A full geology report was prepared by Wallace C. Koster, Consulting Geologist. During August and September of 1979, 13 additional borings, G-101 through G-113, were made around the periphery of the active landfill for the installation of monitor wells. Data from these were reported by a panel of experts, including Robert Ham, PhD; Don L. Warner, PhD; and Richard W. Eldredge, P.E., in an Evaluation of the Mallard Lake Landfill for the Forest Preserve District of Du Page County. In November of 1979, five additional subsurface borings, B-21 through B-25, were performed in the northern portion of the site for James Douglas Andrews, P.E., Environmental Engineering, Inc. on behalf of E & E Hauling, Inc., with Geologist Roberta L. Jennings on-site, in preparation for future development of that portion of the site. Those results are included herein.

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Utilizing previous data as well as new data to integrate the whole, this report discusses the geologic history and stratigraphy; hydrology; continuity of permeable layers in the subsurface; attenuative capacity of the soils; the water balance; and monitoring. Both regional and site-specific information is included. Attached are geologic columns representing subsurface data from the site; a stylized representation of the interpreted site geology; calculations used for reported figures, a table of test results from selected samples, and logs for all borings and monitor wells. Refer to Drawing Number 77-102F-2 for boring and resistivity locations.

DEPOSITIONAL HISTORY AND SITE STRATIGRAPHY

The site is located in an area which has been subjected to extensive and repeated glaciation. Sediments from the most recent period of glaciation, the Wisconsinan, are present. Earlier glacial deposits, if once present, have been eroded away. At least two, and probably three, pulses of glaciation have deposited till sediments at the site, as well as the accompanying lacustrine and fluvial sediments from proglacial and interglacial environments. These sediments overlie Silurian Niagaran Dolomite which forms the bedrock in this region.

The site is situated on the Wheaton Moraine which is composed of the Wadsworth Till Member of the Wedron Formation, an extremely clayey and silty clayey grey till with local lenses of sand and silt. This drift varies from 20 to 40 feet and is recognized over the entire site, with the exception of the river valley formed by the intermittent tributary to the headwaters of the West Branch of the Du Page River. In this portion of the site, the Wheaton Drift has been partially eroded away.

Between the tills of the Wheaton Moraine and the underlying tills of the West Chicago

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Drift, there appears to be an interglacial environment composed primarily of lacustrine deposits, some minor fluvial deposits, and, in some areas, the contact of one till overlying the other without interruption. The location of this environment varies considerably over the site, starting near elevation 765 at the west and dipping below 750 in the central and eastern portions of the site. Although evidence for the environment is abundantly present, including the lake clays, organic layers, and fluvial sediments, there is little or no evidence of any continuity of permeable layers contained within the environment. The lake clays appear to be highly impermeable. With the exception of the tributary valley, where permeable sediments are to be expected, and with the exception of minor, isolated, thin sand layers, confined within the Wheaton Drift, there are only two occurrences of permeable sediments above elevation 750; these are found in B-1 and B-7. Borings adjacent to and surrounding these, do not show evidence of similar permeable layers. Although B-1 and B-7 have similar surface elevations, and their sand layers similar thicknesses, the top of the sand layer at B-1 is at elevation 755, and the sand layer at B-7 is at elevation 771. There is nothing to indicate that these layers are continuous, despite their thicknesses of 12 and 9 feet. Borings on the north side, including B-2 and B-21 through B-25, show uninterrupted till with possibly some lacustrine sediments to below elevation 750, where one small sand lense was present in B-21, and an organic layer in B-2. Beyond that, uninterrupted till exists to elevation 720 where fluvial and lacustrine layers were shown to be present in B-2 and B-22.

Stratigraphically, the West Chicago Drift underlies the Wheaton Drift, and is also composed of the Wadsworth Till Member of the Wedron Formation. Consequently, the two tills, where they are not separated by an intervening layer are not readily distinguishable, one from the other. Although grain size analyses for the tills are varied, several samples have been recognized, through grain size comparisons and stratigraphic position, which

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tentatively identify the presence of the West Chicago tills. There is another lacustrine/fluvial environment which varies between elevations 720 and 700, beneath which there is evidence of another till sequence. It is believed that the till is the Yorkville Till Member of the Wedron Formation, and part of the Minooka Drift. However, grain size data available for the lower till suggest that it could be part of the Malden Till Member or the Haeger Till Member, all of the Wedron Formation. The site is located such that any of the three might be present. The unit is underlain by a third environment of lacustrine and fluvial soils which overlie the Silurian Niagaran Dolomite. The fluvial soils feed the bedrock aquifer which supplies drinking water to the region surrounding Mallard Lake.

The surface sands and gravels of the tributary valley were deposited subsequent to erosion which formed the valley, and are part of the Cahokia Alluvium. Some deposits of the Henry Formation may also be present stratigraphically lower within the valley. These deposits are not geologically continuous with the specific site deposits.

HYDROLOGY

The existing surface of the site slopes gently from the west to the east, and surface drainage is primarily by sheet flow and shallow ravines to the east where an intermittent tributary flows north and west into the West Branch of the Du Page River. Despite the great amount of data collected at various times for the Mallard Lake Landfill site, very little is clear regarding the movement direction of groundwater. To determine the direction of the upper portion of groundwater flow, several wells would have to be left open and unscreened for several months and allowed to stabilize. This has not been done, nor is such a determination considered critical, as the overall body of groundwater moves primarily through impermeable materials at extremely low rates. It has been generally assumed that the groundwater gradient conforms somewhat to the morphology of the land

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surface. At this site, the groundwater most likely has a northeast component of flow.

Of the five (5) new borings, B-21 through B-25, and B-2 on the north side of the site, B-23, 24 and 25 penetrated no permeable layers, were dry at completion, and remained dry after 24 hours. B-21 penetrated a small sand layer at elevation 749 and some water entered the hole. The water was mostly brought up with the auger as drilling continued, and at completion the hole was dry, but had closed at elevation 768.5. B-2 and B-22 penetrated interglacial layers near elevation 720. Water levels after 24 hours were at elevations 741 in B-2, and 728 in B-22. In B-22 the hole had closed at elevation 727. During drilling of B-22, the auger remained in the hole overnight prior to continued drilling below the sand layer, and the water level was at that time elevation 742. Borings from the north side of the site indicate a lesser occurrence of permeable layers than were encountered on the south side.

Throughout all borings on the site for which water level information is available, the following applies; Those that have been terminated above elevation 750, although minor amounts of water may have been encountered during drilling from isolated lenses, were dry or very nearly dry upon completion and after 24 hours; of the nineteen (19) that went below elevation 750, but terminated above elevation 720, seven (7) were dry upon completion, and ten (10) had water levels at varying elevations. Of those, three (3) had only a few feet of water in the hole, four (4) contained water to approximately half their length, and three (3) had high water levels. Some of those contained minor permeable lenses; some did not. No direct correlation could be made with respect to the various levels. All of the ten containing water were scattered about the south side. For two wells there were no data.

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Seven of the borings went below the 720 elevation but did not penetrate both remaining lacustrine/fluviol environments. Four of these penetrated one such environment. Of those, three showed water elevations near 740, and the fourth was at elevation 750. However, the fourth, B-3, is located in the sediments of the tributary valley, and the water level was undoubtedly influenced by the surface sediments. Of the three which did not penetrate interglacial sediments, one was dry and there is no data for the other two.

Two borings, B-1 and B-4, penetrated the last fluvial/lacustrine environment which overlies the bedrock aquifer at elevations below 685; water levels were at elevations 771 and 741, respectively.

CONTINUITY OF PERMEABLE LAYERS IN THE SUBSURFACE

Despite directions of movement in the flow of the overall groundwater body at the site, the primary fluid movement of concern to a landfill investigator is that through permeable layers. Although there is a strong vertical gradient at the site, if continuous permeable layers occur, preferential lateral flow is likely to exist and at a much higher rate than through the impermeable tills.

The data indicates that three till sequences and three interglacial environments are present at the site, although the contacts and thicknesses are not everywhere clearly definable and vary in elevation throughout the site. The main interest herein is to define as nearly as possible any permeable pathways through which fluids might preferentially travel.

Numerous permeability analyses on samples from the site show that the majority of the geologic column is composed of highly impermeable glacial tills and lacustrine soils.

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Avenues for fluid travel will be through the fluvial sands and gravels, and only to the extent to which they are continuous.

Within the body of the till deposits may be found numerous lenses of sand and silt and small concentrations of gravel, but such are generally thin and isolated. In terms of fluid travel, they can be assumed as part of the impermeable till fabric. The probability of such pockets and lenses being continuous over any wide lateral extent is very low. The interglacial environments, although often no more than the contact between two tills, will, conversely, have the greatest probability at any given point of containing permeable layers of much wider continuity.

It is obvious that the uppermost interglacial environment below the Wheaton Till is composed primarily of the impermeable lacustrine sediments. The occurrence of permeable fluvial sediments is relatively minor, and there is no indication of continuity among those observed.

The few data points for the second interglacial environment suggest that some continuity of fluvial layers may exist although not everywhere over the entire site. The third interglacial environment, because of the thickness of fluvial deposits and their location above the bedrock, is thought to be widely continuous.

Continuity of permeable layers beneath the site to the surface sands and gravels in the tributary valley is not expected to exist. There is no evidence of continuity in the upper interglacial environment and therefore a low probability of any hydrologic connection. The second interglacial environment containing fluvial deposits is well below the base of the surface sands and gravels in the tributary valley, and is separated from them vertically by impermeable soils, and therefore cannot be hydrologically connected.

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Of all the borings within the till sequence at the closest approach to the valley, the highest occurrence of a fluvial layer or lense is elevation 733. The base of the sands and gravels of the tributary valley, as shown by B-3, and B-8 at the downgradient end, is at elevation 748 and 758 respectively, and is underlain by impermeable material.

The hydraulic gradient at the site is primarily vertical. Any opportunity for lateral movement of fluid will be through the sediments of the second and third interglacial environments and the bedrock aquifer itself. Fifty to ninety feet of till and lacustrine deposits exist between the surface and the second interglacial environment, and 70 to 130 feet between the surface and the lower fluvial environment which overlies the bedrock aquifer.

Although the lower fluvial sediments feed the bedrock aquifer, where a till sheet separates the second interglacial environment from the lower, the second cannot feed the lower without first passing through that till sheet at the extremely low rate that the low permeability of the till dictates. There is virtually no probability that the fluid in lenses of the first interglacial environment could feed the second fluvial layer because there is everywhere impermeable sediments separating them.

RECOMMENDATIONS PERTAINING TO DEPTH OF EXCAVATION

Although some sand lenses are present within the first interglacial environment, primarily just below elevation 750, there are indications that these are not continuous to any extent. It is thought that the limiting level within the subsurface will be the upper surface of the second interglacial environment which may contain continuous fluvial layers, and exists below elevation 720. Because of this, the limiting trench invert ele-

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vation, should be fixed at 730, or above. Because ground surface elevations range between 770 and 820, excavation to a depth of elevation 730 is not everywhere practical. Because some sand lenses occur near the 750 elevation, where excavation is to reach similar depths, it should proceed lower so that any such lenses may be identified and either removed by excavation or sealed off by 10 feet of clay material. Such lenses are expected to be encountered less frequently on the north side than on the south side of the site.

Conceivably, landfill excavation to average depths of 40 or 50 feet over most of the site could be accomplished without being a source of environmental concern. Ten to forty feet would remain between the trench invert and the second interglacial environment with its fluvial layers, and 35 feet would be the average over the site. Thirty to ninety feet would exist between the trench invert and the lower fluvial sediments which feed the bedrock aquifer, with 80 being the average over most of the site. The minimum occurs only near the eastern edge where the land surface slopes to the east. Such thicknesses are far more protective than the required minimum 10 feet.

All drinking water wells recorded for the area are within the lower fluvial environment or the bedrock aquifer itself. The probability of contaminants reaching this level in the subsurface is extremely low. Both the large till sequence and the second interglacial environment protect the aquifer. If continuous fluvial layers exist in the second environment, any contaminants which might remain in the fluid which reaches that level, will be diverted through that pathway. However, for at least a two mile radius around the site, there is no lateral outlet to the surface at elevation 720 or lower, even if the fluvial layer was widely continuous. It is thought that even with

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some lateral diversion locally, the fluid must eventually migrate downward and the strong vertical gradient at the site suggests that this is what is happening.

An additional limitation to excavation and fill at the site are the lateral limits imposed by the surface fluvial layers in the tributary valley. The limit of these sediments appears to coincide generally with the flood plain near elevation 775 to the east and 780 to the north.

THE WATER BALANCE

Calculation No. 1, attached, is the Water Balance computed for the Mallard Lake Landfill Site. Once final cover has been emplaced, because the runoff value is greater than the surplus value, all surplus moisture will become runoff, and none will be available to infiltrate through final cover. However, some liquid enters the fill while it is active through direct precipitation, and some has been introduced as waste.

As Calculation No. 2 shows, typical dry refuse at field capacity can contain 29.7 volume percent fluid with a density equal to water. Wastes received at the Mallard Lake Landfill between July 1, 1979 and July 1, 1980, were composed of 2,954,165 cubic yards of dry refuse and 1,299,400 gallons, or 6,432 cubic yards of liquid. Assuming the compacted dry refuse equals 1,477,082.5 cubic yards and the liquid has a density equal to that of water, the volume percentage equals .44 percent. Considering that the liquid waste is not 100 percent liquid, that percentage would be even less. Consequently, the liquids added to the fill as waste are far below field capacity, by as much as two orders of magnitude. Without some moisture, stabilization will take many years. Although uncontrolled liquid addition to the fill is not desirable, it is

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believed that some liquids would be beneficial in encouraging early biological and chemical stabilization. Unless stabilization can occur to some degree during the active life of the fill, stabilization and settlement will continue far into the future, and thus perhaps complicate the future use of the site. A fill with some liquid passing through it can stabilize in as little as five to ten years. Without liquid, stabilization may not begin to occur for 20 years or longer.

Under current permit conditions, the maximum allowable leachate mound surface is fixed at elevation 780. At nearly all points over the site, this is below the ground surface such that fluid pressure cannot threaten the stability of the above grade sideslopes. In addition, a leachate collection system has been installed to ensure that the 780 elevation is not exceeded. However, because the refuse will always be well below field capacity, and no liquid will enter the landfill through final cover, no leachate mound is ever expected to build up.

CONTAINMENT TIME

Because no liquid is expected to enter the fill after closure, the gradient which governs the rate at which fluid can exit the fill will always be less than one. Consequently, for the purpose of calculating containment time, a gradient of one has been assumed. Calculation No. 4 assumes an average 40-foot trench depth with 35 feet of impermeable material between the trench invert and the nearest underlying permeable layer, 80 feet between the trench invert and the lower aquifer, and average coefficient of permeability of 3.0×10^{-8} cm/sec. for impermeable materials and 1×10^{-6} cm/sec. for permeable materials, which is typical for glacial sands containing some silt and clay.

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Calculation No. 3, attached, shows that 1127.6 years will be required for a volume of fluid to pass into the fluvial layers of the second interglacial environment. Should lateral diversion along those layers occur, an additional 160 years will be required for the fluid to move 100 feet, or 16 years if 1×10^{-5} cm/sec. permeability is assumed.

For fluid to reach the lower interglacial environment which feeds the bedrock aquifer, 2577.4 years would be required. Even if, owing to unusual or unlikely circumstances, the leachate head were ever to reach the maximum allowable, the containment times for fluid to reach the first permeable layer and the aquifer would be 663.4 years and 1982.6 years, respectively.

Because the calculations are for average conditions which exist over the majority of the site, caution is advised in limiting conditions, such as where the surface elevation drops below 795 near the eastern edge. Excavation may be at less than 40 feet along the eastern edge of the fill to ensure the most beneficial conditions.

ATTENUATIVE PROPERTIES

Although the ion exchange capacities at the site are not as high as might be desired, the great thicknesses of impermeable sediments through which contaminants must pass will provide large areas for attenuation. Calculation No. 4 shows that, assuming average permeability, for every 1 foot by 1 foot column 35 feet thick, over 1500 years would be required before all available exchange sites would be exhausted, once the landfill fluid begins to pass through the soils; and in a 1 foot by 1 foot column 80 feet thick, over 3500 years would be required. Clay minerals typically present in Lake Border tills include 14 to 20 percent expandables; 65 to 74 percent illite;

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and 9 to 16 percent chlorite and kaolinite.

Further, the unusually high clay contents of the tills, and low permeabilities, will provide low flux and very long contact times, and attenuation by other means, including precipitation, adsorption, microbial decomposition, and soil filtration, is expected to be high.

MONITORING OF THE SITE

For maximum utility, monitor wells should be located strategically to monitor the interglacial environments where permeable layers or lenses have a high probability of being continuous. Many lenses of sand are isolated within the till sheet and reflect only what fluid within the till sheet itself will reflect.

The leachate front is expected to travel primarily downward. Leachate below the site cannot escape to the surrounding environment until 1) it is laterally diverted and can travel beyond the property boundaries, and 2) it reaches the aquifer. Consequently, possible paths of lateral migration should be monitored.

In the first interglacial environment, although minor fluvial lenses do occur, there is no evidence of continuity. Consequently, it is difficult to predict their occurrence and set a well although the environment itself could be located and monitored.

The second interglacial environment, where fluvial layers occur, should definitely be monitored, as these layers have the highest probability of lateral continuity within the upper portions of the glacial sediments.

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The third interglacial environment which feeds the bedrock aquifer should also be monitored -- not because pollution is expected or even deemed probable at that depth-- but simply because that is the layer which above all must be protected, because it is an aquifer and supplies the local drinking water. Such wells will probably never "see" pollution, but are a "fail safe" against any highly improbable occurrences.

A final environment to be monitored is the surface sands and gravels in the tributary valley. Any movement of leachate along the surface of the groundwater table will eventually be toward the valley. Although hundreds of years are expected to be involved, such wells would reflect both the groundwater surface as well as any surface drainage pollution, should it ever occur.

A full monitoring program should be designed, including "fail safe" monitoring, with approximately 25 to 30 wells at intervals around the perimeter, including wells already in place. Many of the existing wells currently monitor the first interglacial environment around the south hill where permeable lenses are more prevalent. Wells on the north side, where permeable lenses are not evidenced at that level, would best serve the continued program by monitoring the second and third interglacial environment.

CONCLUSIONS

The overall geology of the Mallard Lake Landfill site is considered to be excellent for the purposes of landfilling. Not only the required 10 feet, but much larger thicknesses of impermeable material separates the landfill from its surrounding environment. The paths of fluid travel from the specific site are reasonably predictable, and intel-

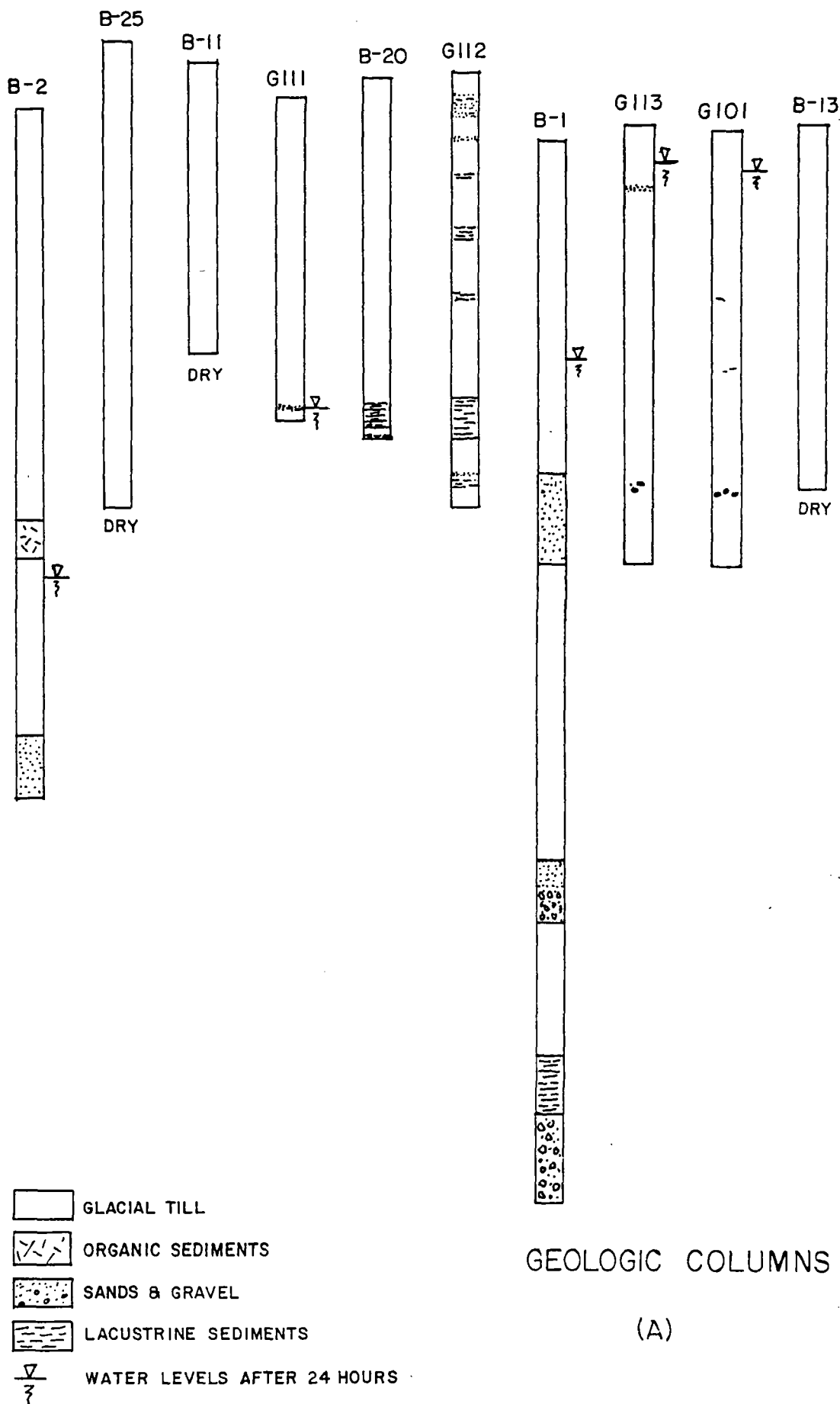
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ligent monitoring of the site can provide for even "fail safe" conditions. The aquifer will be protected by 40 to 90 feet of till. Whether fluid movement is lateral or vertical and in all directions, several hundreds of years are calculated to elapse before landfill fluid can ever leave the site boundaries or reach paths of possible lateral movement. Prior to the entrance of landfill fluid into the environment, contaminants should be attenuated to acceptable levels.

ELEVATION

810 —
800 —
790 —
780 —
770 —
760 —
750 —
740 —
730 —
720 —
710 —
700 —
690 —
680 —
670 —
660 —
650 —

R-10



GEOLOGIC COLUMNS

(A)

ELEVATION

810 —
800 —
790 —
780 —
770 —
760 —
750 —
740 —
730 —
720 —
710 —
700 —
690 —
680 —
670 —
660 —
650 —

R-9

B-21



DRY

B-23



DRY

B-24



DRY

B-12



$\frac{V}{f}$

B-7



DRY

B-15



$\frac{V}{f}$

G102



DRY

B-5



G103



DRY

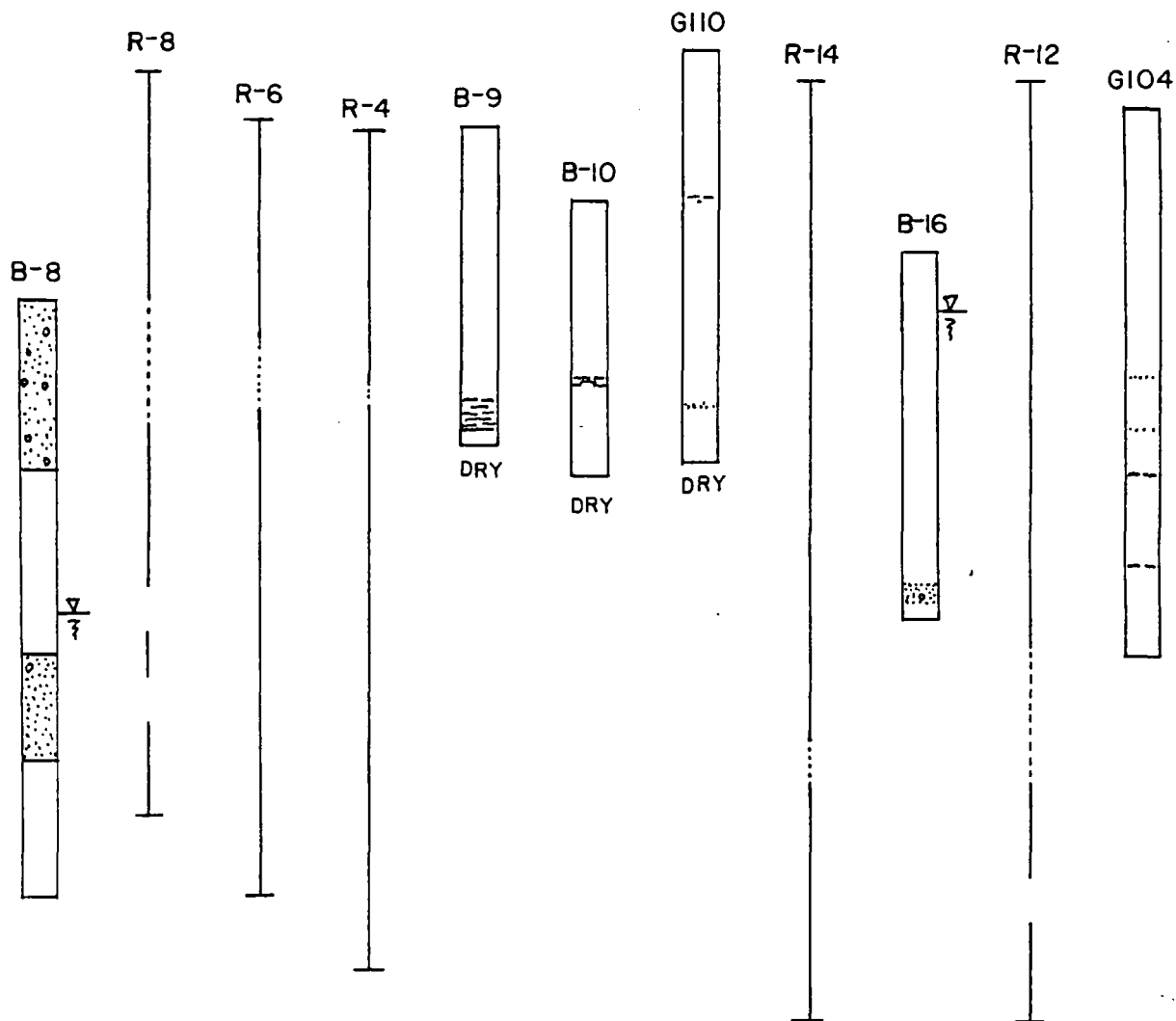
G105



(B)

ELEVATION

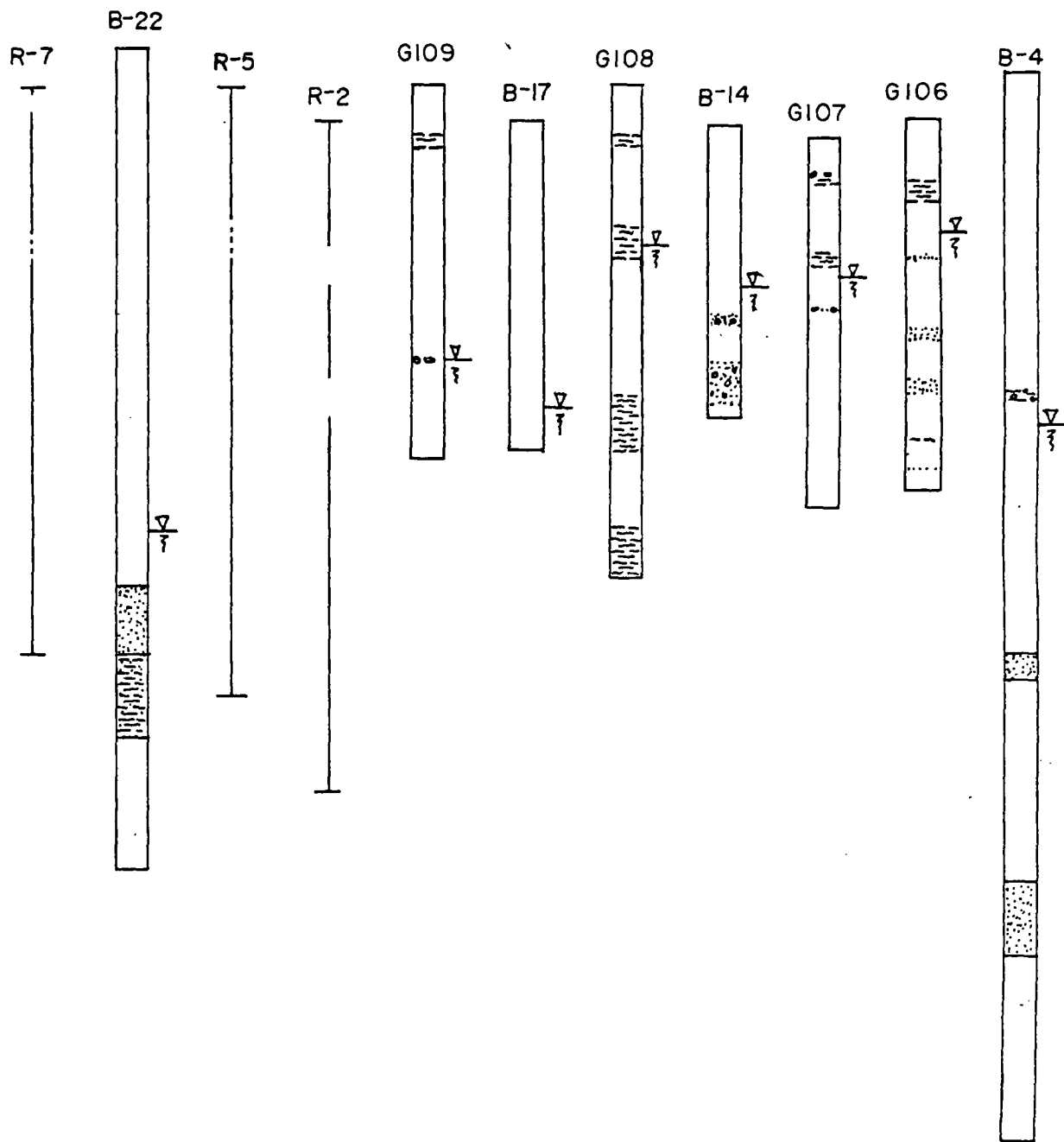
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690 —
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660 —
650 —



(C)

ELEVATION

810 —
 800 —
 790 —
 780 —
 770 —
 760 —
 750 —
 740 —
 730 —
 720 —
 710 —
 700 —
 690 —
 680 —
 670 —
 660 —
 650 —



(D)

ELEVATION

810 —

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790 —

780 —

770 —

760 —

750 —

740 —

730 —

720 —

710 —

700 —

690 —

680 —

670 —

660 —

650 —

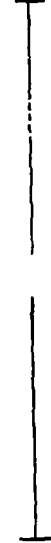
B-3



R-3



R-1



B-6



B-18



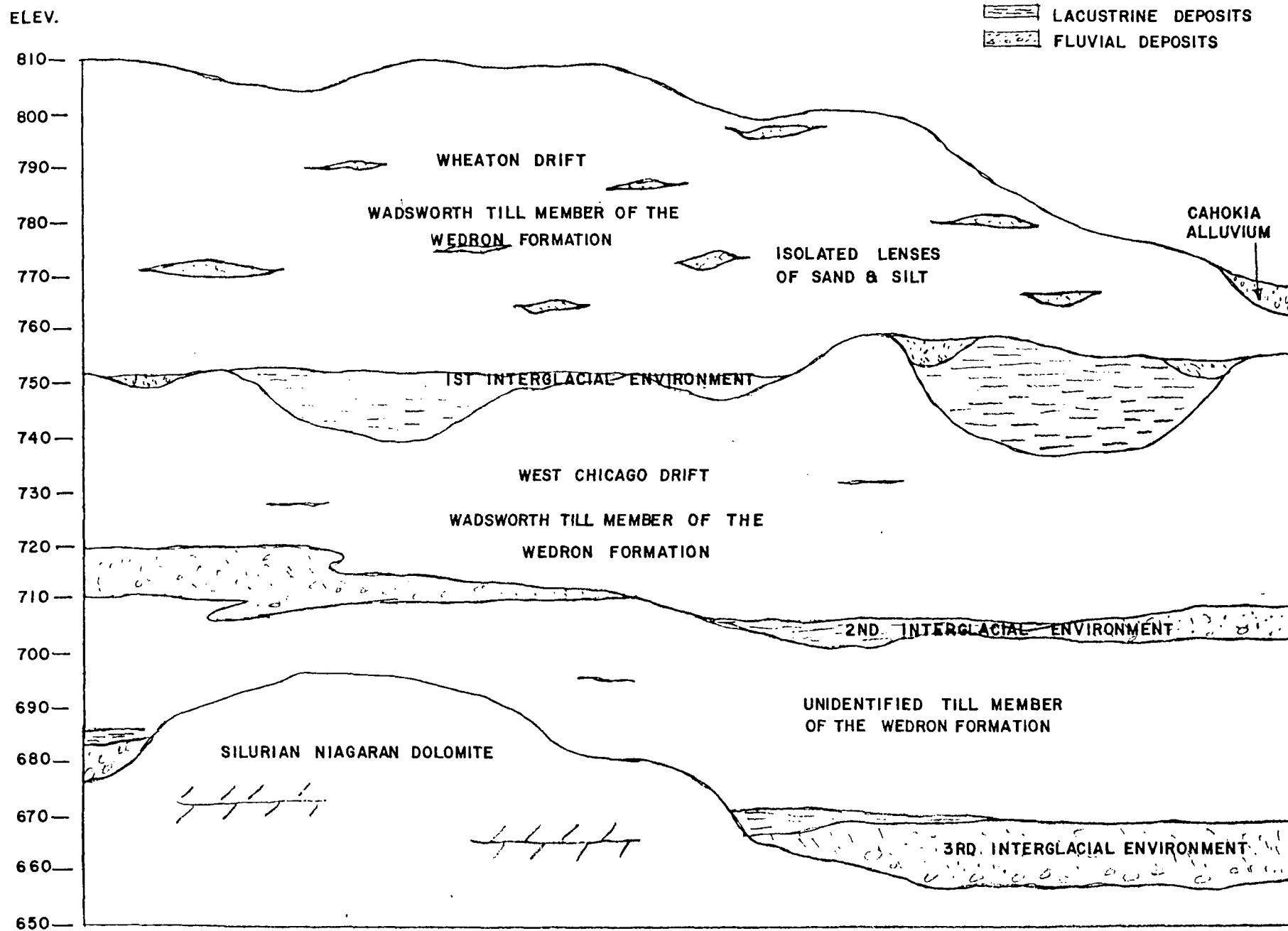
DRY

B-19



DRY

(E)



STYLIZED REPRESENTATION OF SITE GEOLOGY